FIG. 1

100

FIG. 2

File	Images	Context	etc.		Help

Graphical
Context
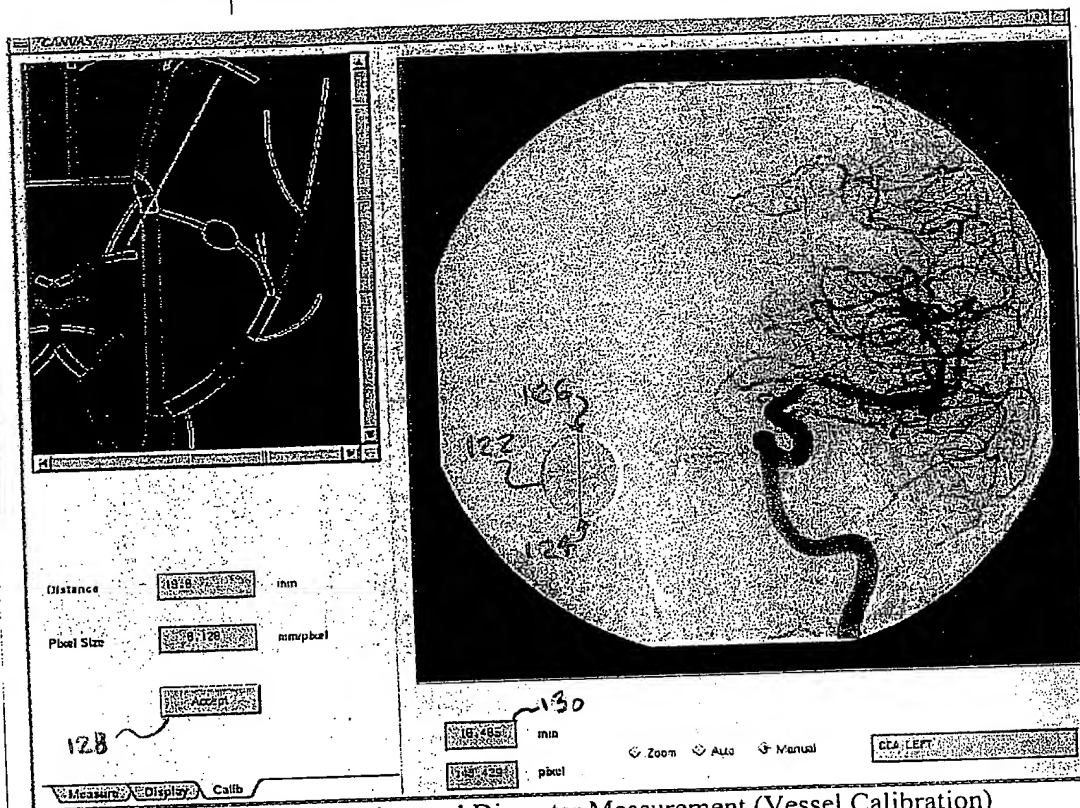Representation   — 112
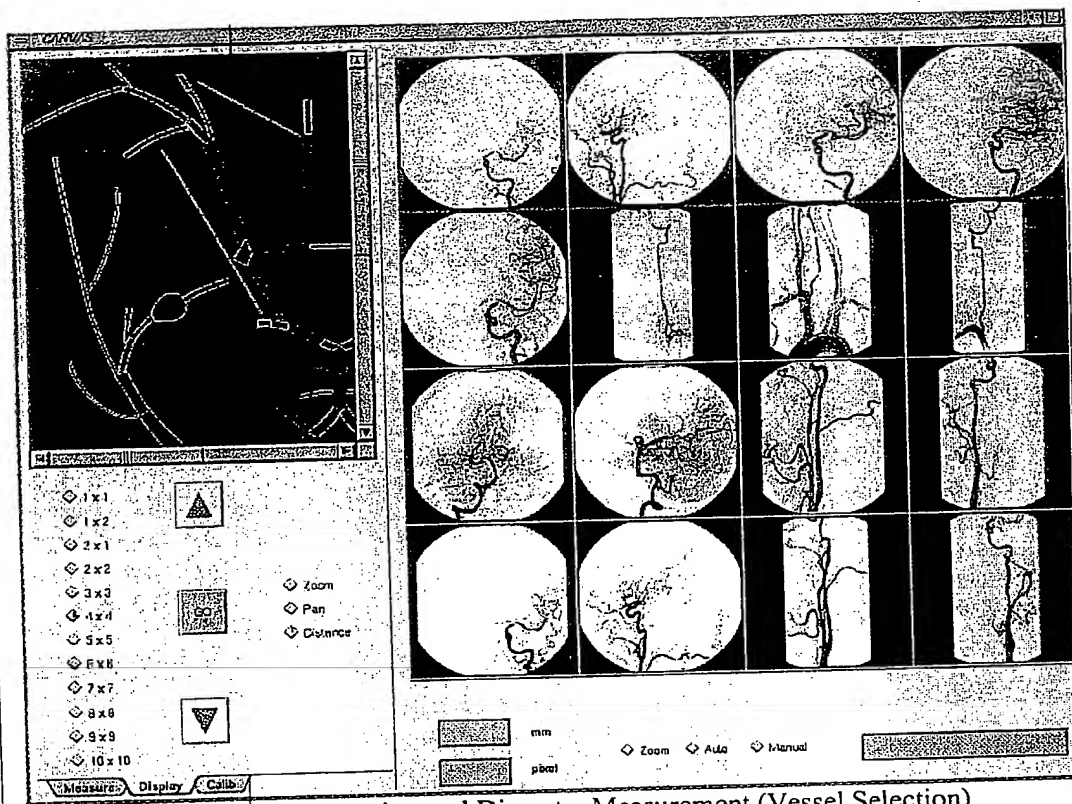
Image Work
Area   ← 114

118

Process Status

116

119

110

FIG. 3

Vessel Extraction and Diameter Measurement (Vessel Calibration)

120

FIG. 4

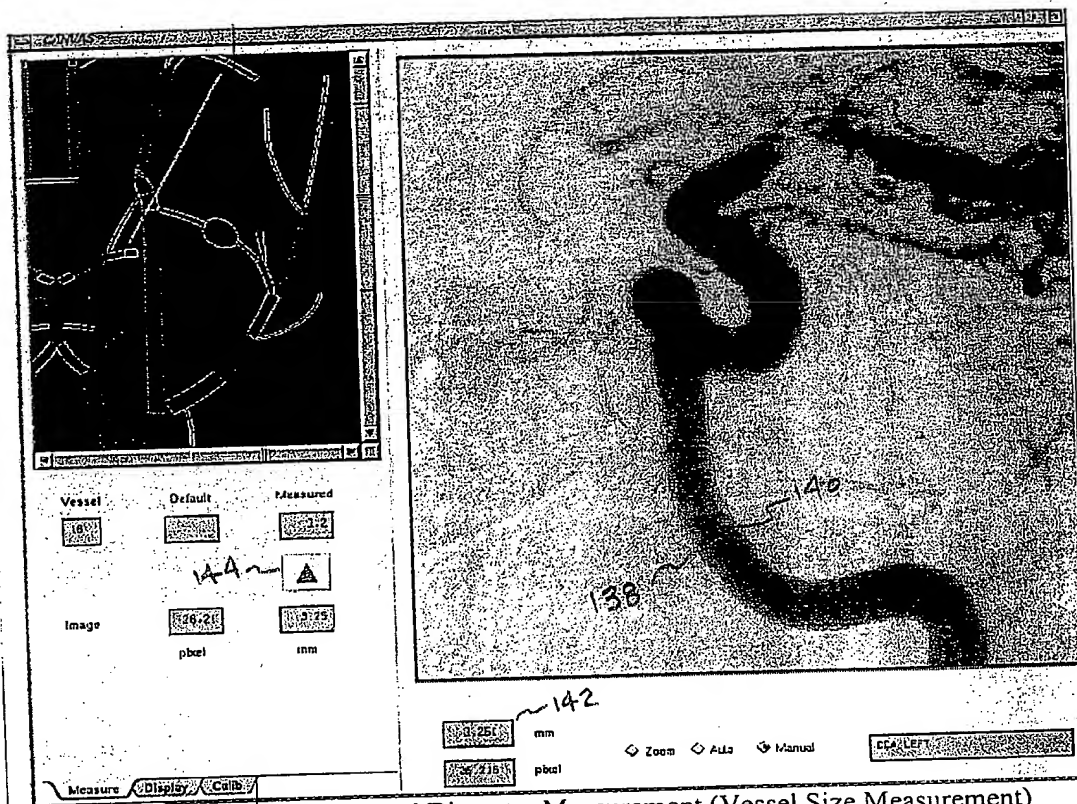Vessel Extraction and Diameter Measurement (Vessel Selection)

130

FIG. 5

Vessel Extraction and Diameter Measurement (Vessel Size Measurement)

<u>136</u>

FIG. 6

(a)   (b)   (c)

FIG. 7

FIG. 8

(a)　(b)
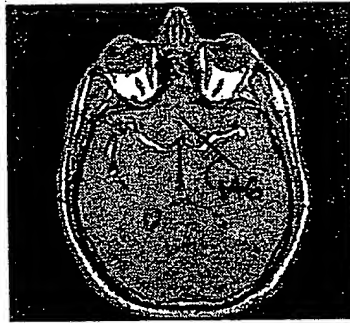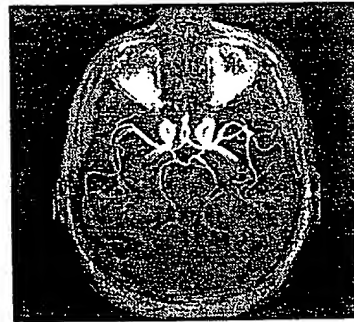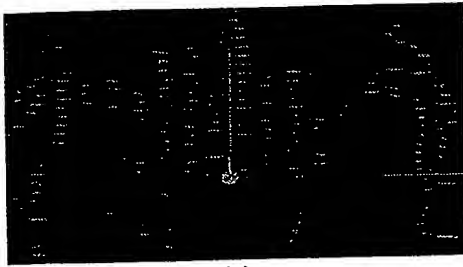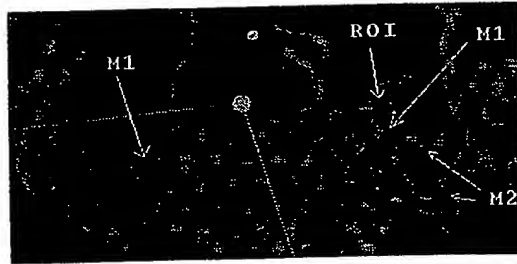
FIG. 9
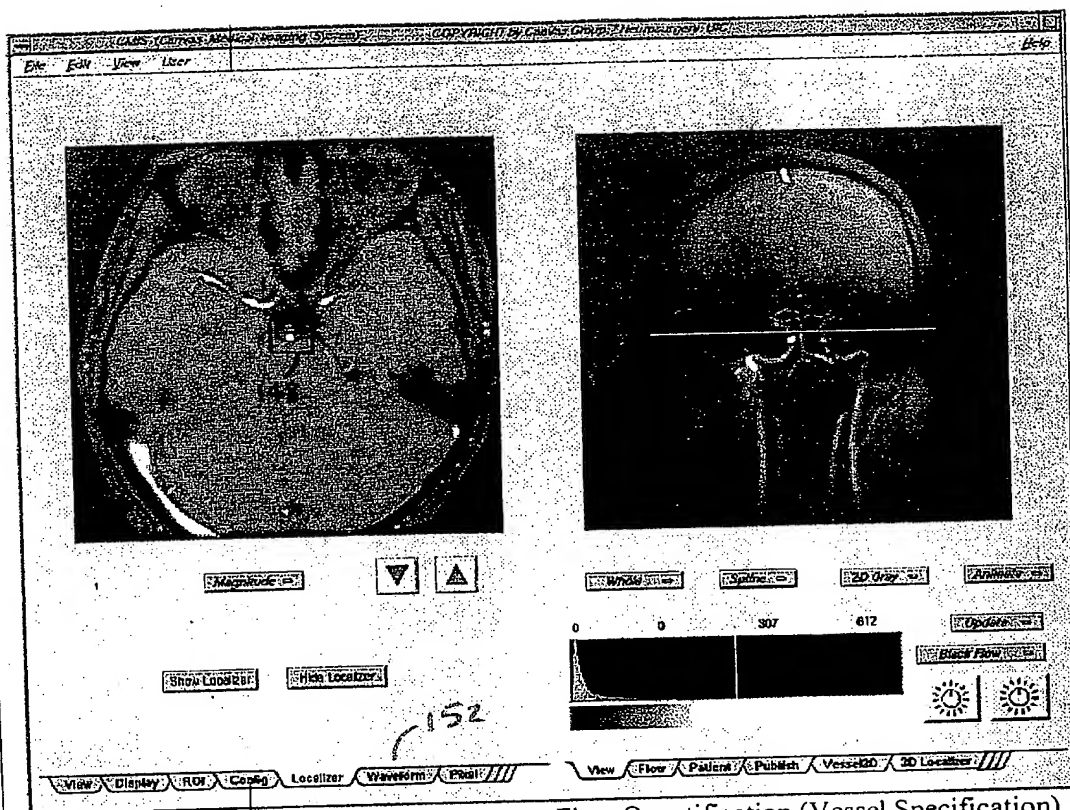
Phase Contrast Magnetic Resonance Flow Quantification (Vessel Specification)

150

FIG. 10
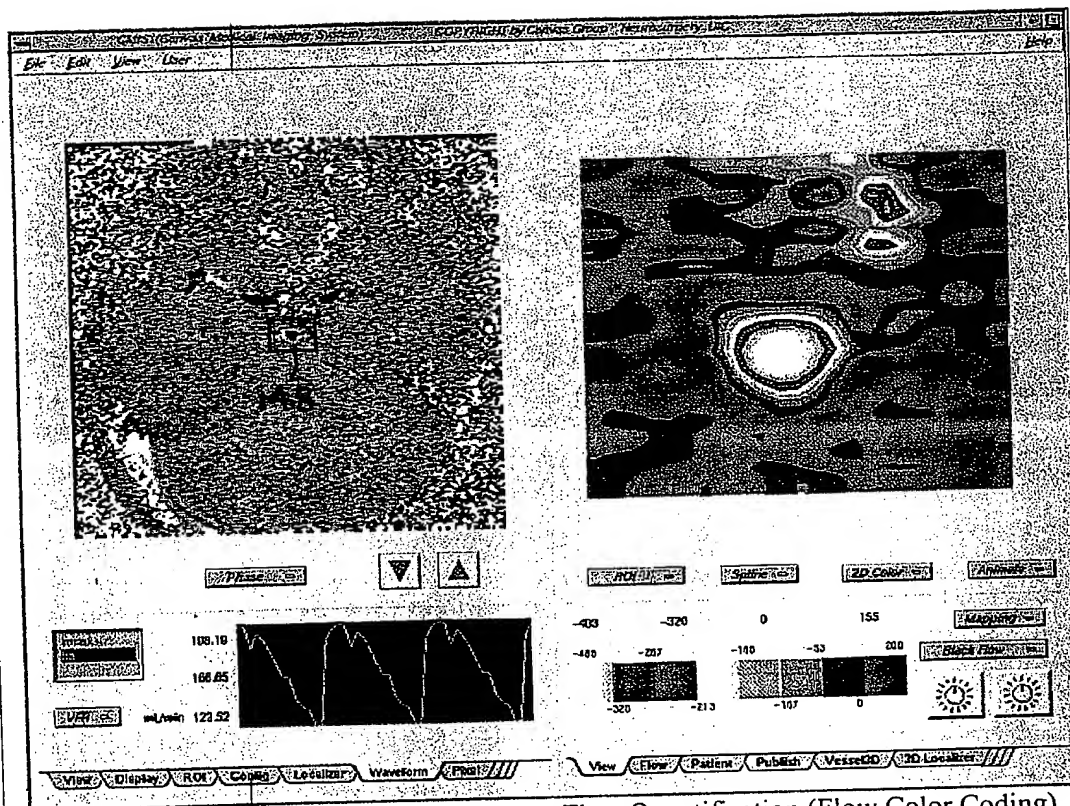
Phase Contrast Magnetic Resonance Flow Quantification (Flow Color Coding)

15A

FIG. 11

Fig.6 Phase Contrast Magnetic Resonance Flow Quantification (3D Pulsatile Flow)

156

FIG. 12
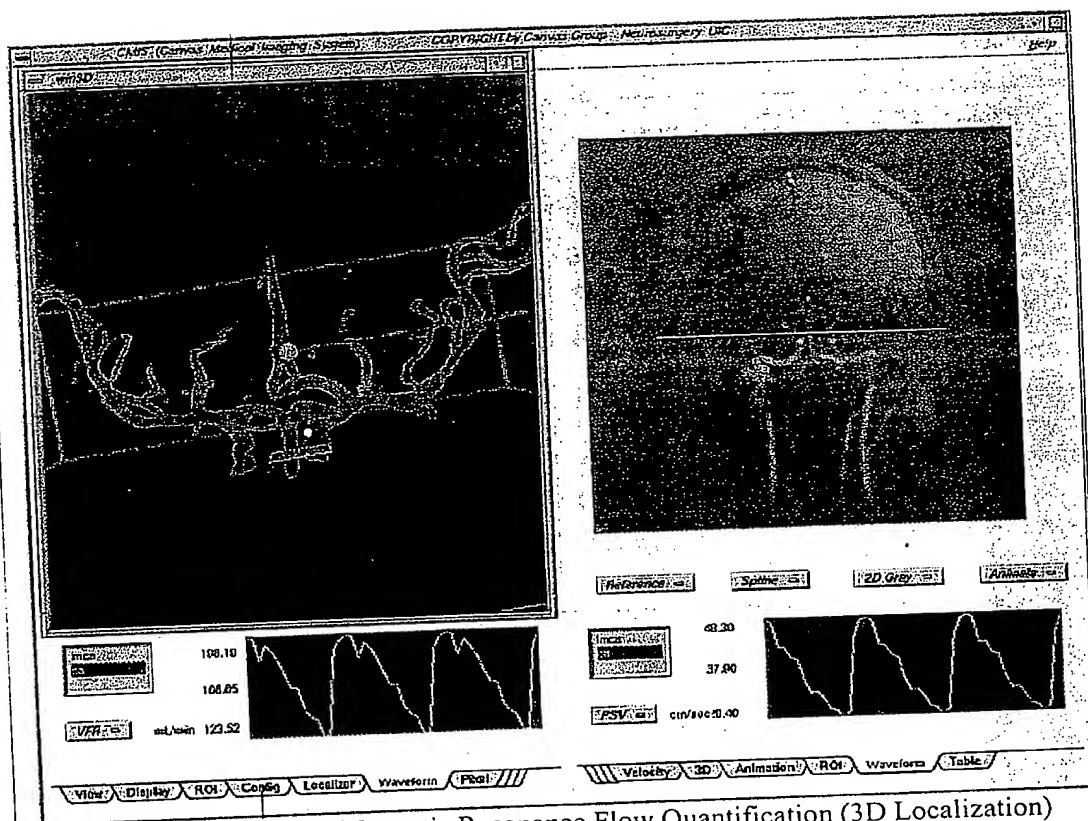
Fig.7 Phase Contrast Magnetic Resonance Flow Quantification (3D Localization)

158

FIG. 13
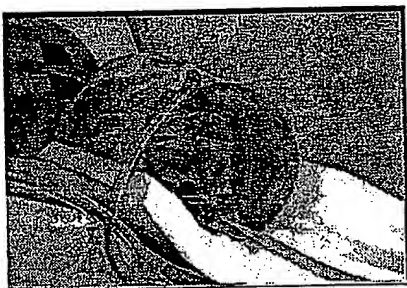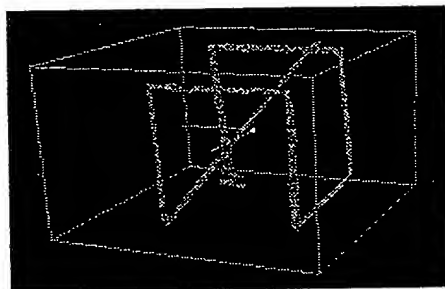
(a) Flow Phantom and (b) 3D surface rendering of the flow phantom.

FIG. 14

(1) (2) (3) (4)
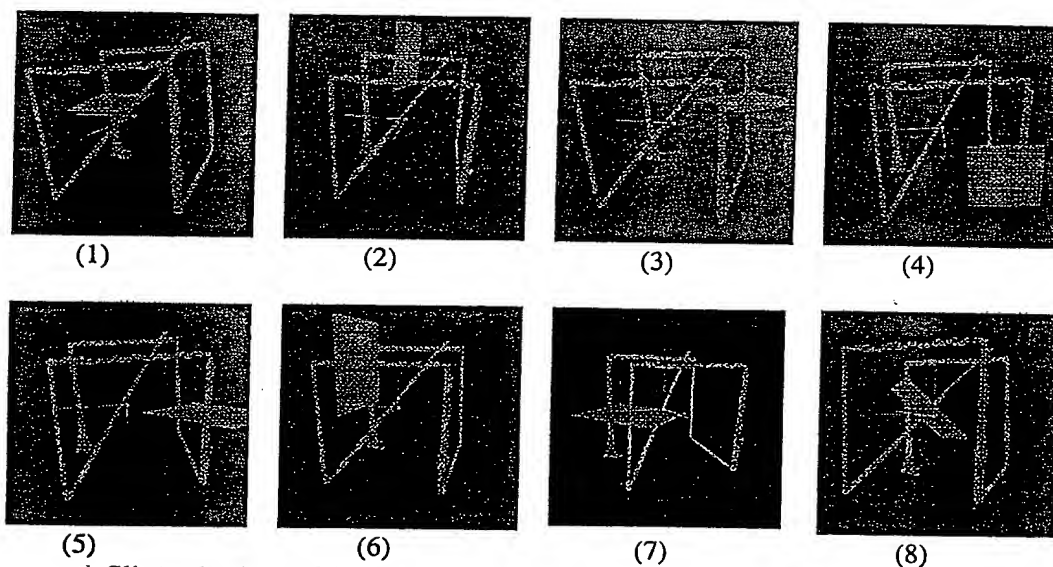
(5) (6) (7) (8)

Slice selections of flow phantom for constant flow measurements in eight tubes

FIG. 15

(1) (2) (3) (4)

(5) (6) (7) (8)

Cine PcmR magnitude images for eight tubes

FIG. 16
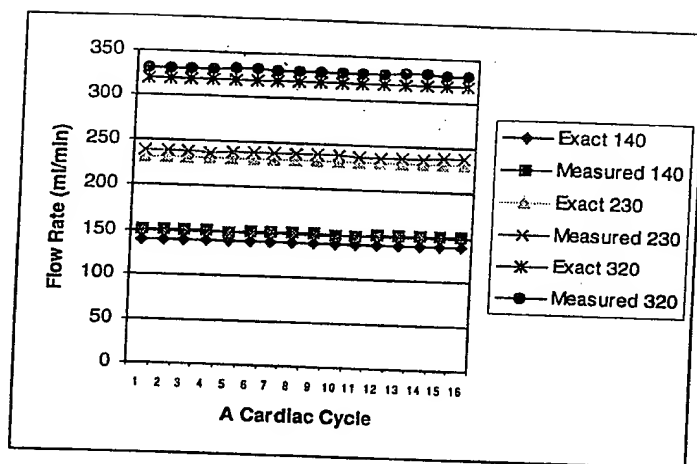
Comparison of Flow Measurements for a Constant Flow Phantom in Three Different Flow Rates (140, 230, and 320 ml/min): Actual Flows vs. PCMR Flow Measurements without Flow Offset Compensation

FIG. 17

Comparison of Pulsatile Flow: MR vs. Transonic Flow Probe
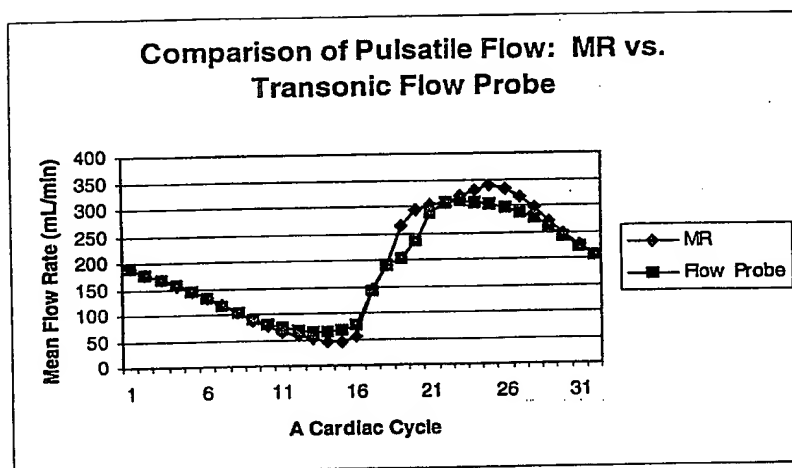
Pulsatile Flow Phantom: Flows Measurements for the tube in the center of the phantom Using PCMR and Transonic Flow probe

FIG. 18
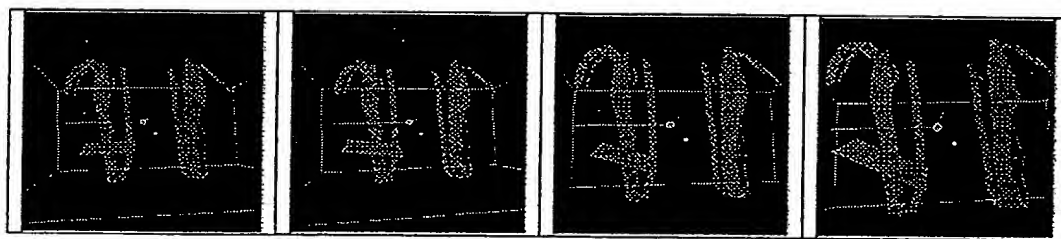
3D surface renderings of perpendicular cut ad three misalignment 10°, 20°, and 30° for the left common carotid artery

FIG 19
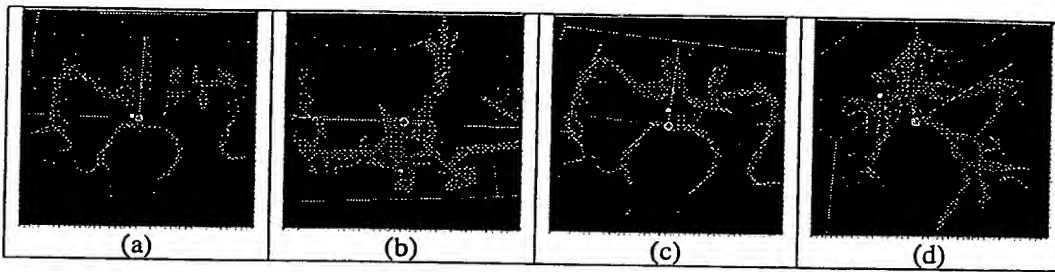
3D localization: the perpendicular cuts for (a) left middle cerebral artery, (b) right anterior cerebral artery, (c) left posterior communicating artery, and (d) a left middle cerebral artery M3 branch

FIG. 20
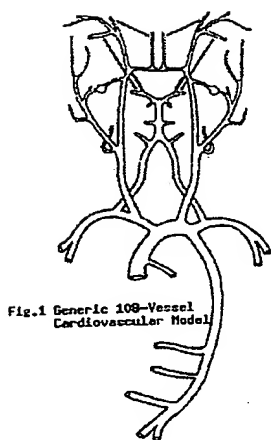
Fig.1 Generic 108-Vessel
Cardiovascular Model

FIG. 21

$t + \Delta t$

t

$X - \Delta X \qquad X \qquad X + \Delta X$
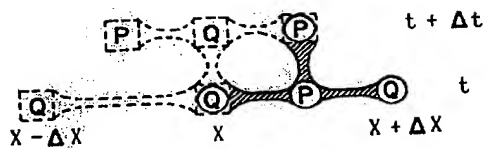
Finite-Difference Scheme

RCR Termination

FIG. 22

Legend:

RMC = Right Middle Cerebral Sector
LMC = Left Middle Cerebral Sector
REC = Right External Carotid Sector
LEC = Left External Carotid Sector
AC = Anterior Cerebral Sector
BS = Basilar Sector
VS = Vertebral Sector

P = Primary Flow
    Inlet or Outlet
S = Secondary Flow
    Inlet or Outlet
T = Terminal Efferent

Seven-Sector
Cerebral Model

FIG. 23

Initialize RCRs, and QGOALs
num_adjust = 0

Flow Chart for
Iterative Algorithm to
Compute RCRs

Initialize pressures and flows at all
nodes in all vessels

period = 0

Update QGOALs
according to
Secondary
InFlows/OutFlows
num_adjust =
num_adjust + 1

Calculate pressures, flows, and
boundary conditions using the
numeric model

Adjust RCRs according to QGOALs

No

period =
period + 1

Do all the sectors meet QGOALs ?

Yes

Is num_adjust
≥
num_adjust_max ?

No

Is period = period_max ?

No

Yes

Output RCRs

Yes

FIG. 24

Angiogram (a), 3D Localizer Image (b), and Flow Waveform (c) for Case 2.

FIG. 25

(a)

(b)

(c)

(d)
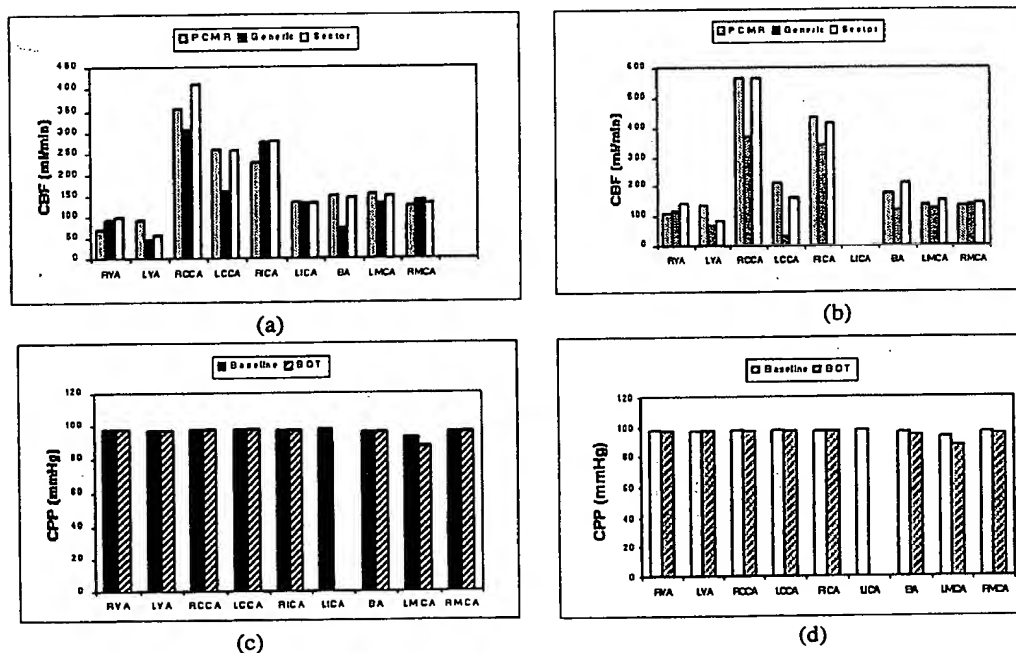
Results for Case 1: (a) Comparison of CBF (Cerebral Blood Flow) at Baseline and (b) post-BOT between PCMRA and simulations from Generic and Sector Models; Comparison of CPP (Cerebral Perfusion Pressure) between Generic (c) and Sector (d) simulations at Baseline and BOT

FIG. 26
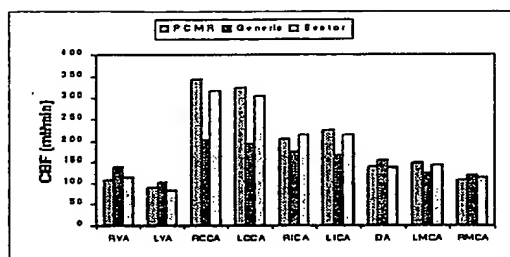
(a) Case 2
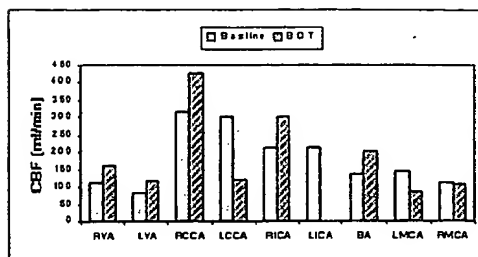
(b) Case 2
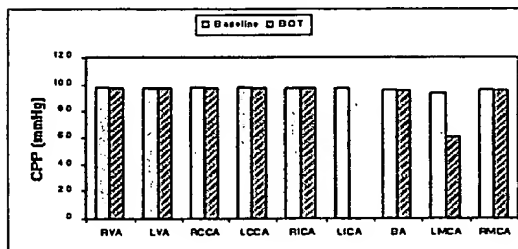
(c) Case 2
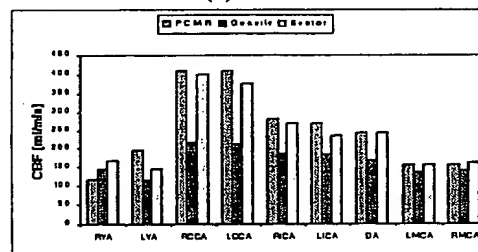
(d) Case 3
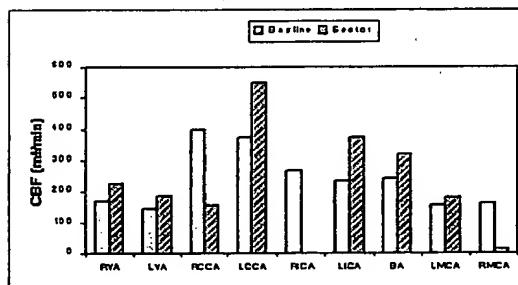
(e) Case 3
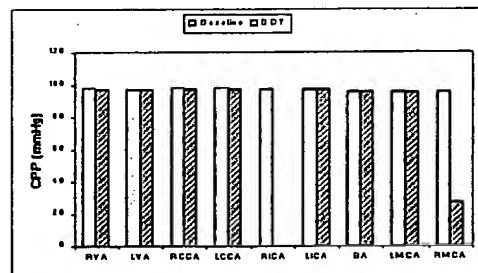
(f) Case 3

Results for Case 2 (a)-(c) and Case 3 (d)-(f): Comparison of CBF at Baseline in Case 2 (a) and Case 3 (d) between PCMRA and simulations from Generic and Sector Models; Comparison of CBF in Case 2 (b) and Case 3 (e) and CPP in Case 2 (d) and Case 3 (f) between simulations at Baseline and BOT

FIG. 27
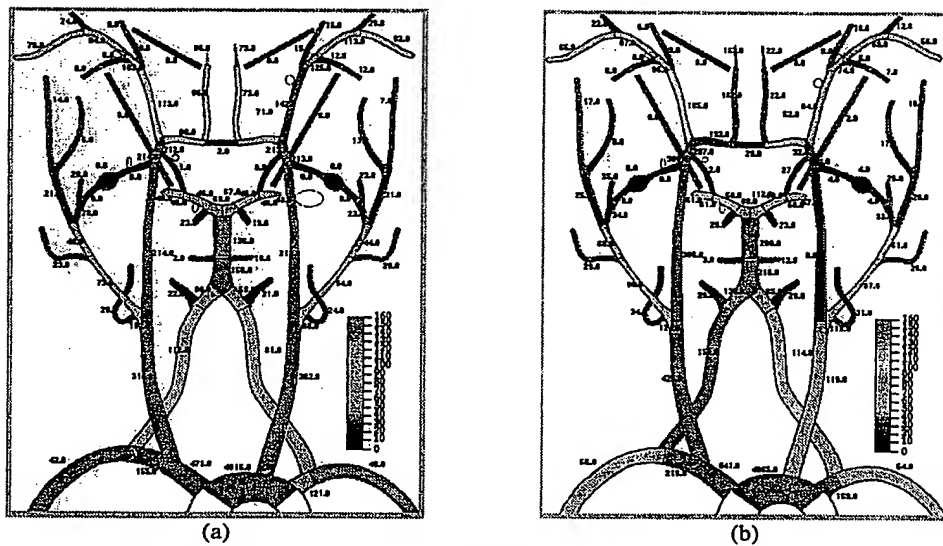
Fig.7 Simulated CBF distributions at Baseline (a) and BOT (b) for Case 2

FIG. 28

```
                              ┌─────────┐
                              │  Start  │
                              └────┬────┘
202 ─┐                             │
     │      ┌────────────────────────────────────────────────────┐
     │      │                    T = 0                            │
     │      │  Initialize pressures and flows at all points in all vessels │
     │      └────────────────────────────────────────────────────┘
     │                             │                                   202
     │      ┌────────────────────────────────────────────────────┐
     │      │                 Equation of State                   │
     │      │  Calculate cross-sectional area at all points using the current pressure │
     │      └────────────────────────────────────────────────────┘
     │                             │                                   204
     │           ┌────────────────────────────────────────┐
     │           │              Mass Balance               │
     │           │      Calculate pressures at all points   │
     │           │   except the pressures at junction centers │
     │           └────────────────────────────────────────┘
     │                             │                                   206
     │           ┌────────────────────────────────────────┐
     │           │          Inlet Forcing Function          │
     │           │   Update pressure sources or flow sources │
     │           └────────────────────────────────────────┘
     │                             │                                   208
     │      ┌────────────────────────────────────────────────────┐
     │      │        Internal Junction Boundary Conditions        │
     │      │  Calculate flows at all junctions and pressures at all junction centers │
     │      └────────────────────────────────────────────────────┘
     │                             │                                   210
     │      ┌────────────────────────────────────────────────────┐
     │      │                 Momentum Balance                    │
     │      │  Calculate the flows at all points except the flows at junctions │
     │      │ Introduce internal flow sources using the special flow forcing functions │
     │      └────────────────────────────────────────────────────┘
     │                             │                                   212
     │      ┌────────────────────────────────────────────────────┐
     │      │           Terminal Boundary Conditions              │
     │      │  Calculate flows at last nodes in all efferent vessels │
     │      └────────────────────────────────────────────────────┘
     │                             │                                   214
     │           ┌────────────────────────────────────────┐
     │           │               T = T + DT                 │
     │           │              Increment time              │
     │           └────────────────────────────────────────┘
     │                             │                 216
     │                          ◇ Check ◇
     └──── T < Tmax ◄───────────┘         └──────► T = Tmax ──────► ( Stop )
```

200

FIG. 29